

Richard A. HOWARD initiated his botanical work in 1950 with a field trip from Trinidad through all the Lesser and Greater Antilles. He could have decided to focus on the Greater Antilles, but responsibilities in administration and teaching, and possibly the enormous work involved in covering properly some 9000 to 10000 species with additional collections, prompted his drastic choice to a more limited area. His thesis published in 1952 deals with the Vegetation of the Grenadines, a group of small islands shared by Grenada and St. Vincent and well known to sailing lovers.

The interests of HOWARD developed along three main lines almost entirely within the Caribbean region : Taxonomy, Phytogeography and Botanical History. Besides a number of family monographs written for his Flora, he studied particularly the *Piperaceae* and the genera *Coccoloba* and *Ocotea* pointing out in a slightly disenchanted tone (1979 : 246) that “ still such families as the *Lauraceae*, *Melastomataceae*, *Piperaceae* and *Urticaceae* defy the efforts of a single individual ”.

His production on phytogeography deals with the distribution of genera present in the area (1974), the description of broad vegetation types (1979) and relationships with the environment (limestone in Cuba, bauxite in Jamaica, montane ecology in Puerto Rico, volcanism in the Lesser Antilles).

On the other hand, HOWARD always demonstrated a keen interest in the History of Caribbean Botany, with critical studies on collectors and collections, the introduction of cultivated species and the role of botanic gardens. Many of his studies were published in the *Journal of the Arnold Arboretum*. He retired as a Professor, Arnold Arboretum, Harvard University.

BRIEF REVIEW OF BOTANICAL TAXONOMY IN THE CARIBBEAN

It may be useful to summarize the situation concerning the floras in the Greater and Lesser Antilles since the knowledge of the former is relevant to that of the latter for many reasons.

Just after World War 2, botanical information on the Caribbean was scattered and fragmentary. Besides two tentative floras (Jamaica, Puerto Rico) there were lists of species, materials accumulated in many herbaria, part of which had been destroyed by war and badly needing a critical evaluation and complementary collecting. The only synthesis available at the regional level was the superseded descriptions of about 3000 species by GRISEBACH (1859-1864) for the British possessions, i.e. about one third of the total flora of the Caribbean. At the end of the last and beginning of this century URBAN had endeavoured to summarize the available knowledge in the region (in latin, one of the ultimate botanical works of this kind) but most of his types disappeared in the bombing of Berlin.

Immediately after the war, most of the major islands or archipelagos were covered in a few decades : a flora of Cuba in 5 volumes (1947-1969), of Hispaniola in 8 volumes (5 are published, 1982-1989), a revision for Puerto Rico in progress, a revised flora for Jamaica by ADAMS (1972), the very nice Flora of the Bahamas Archipelago by CORRELL & CORRELL (1982), the flora of the Caymans by PROCTOR (1984).

Concerning the Lesser Antilles, "La Flore pittoresque et médicinale des Antilles" by DESCOURTILZ (1821-1830) is obsolete but still has popular interest for its 600 colour illustrations. DUSS (1897) gave the first serious tentative flora for the French Antilles in two volumes, unfortunately without keys nor illustrations. This work was updated in 1978 by FOURNET (one volume). In the meantime STEHLÉ collected actively and produced lists after 1935, as did QUESTEL (1941), complemented by LE GALLO and MONACHINO for Saint Barthelemy. HODGE (1954) published the first part of a Flora of Dominica (Ferns and Monocots); part 2 (Dicots) was published in 1991 by NICOLSON (see special comment below). GOODING et al. (1965) gave a flora of Barbados; STOFFERS (1962-1984) published a flora of the Netherland Antilles, including St. Martin, Saba and St. Eustatius for the Lesser Antilles.

No synthesis was available before HOWARD's Flora.

STRUCTURE OF "THE FLORA OF THE LESSER ANTILLES"

A period of almost 10 years separates the publications of the three first volumes (Ferns and Monocots) from volume 4 to 6 (Dicots).

Vol. 1 (1974). — *Orchidaceae*, 235 pages, 83 figures, by GARAY & SWEET.

Vol. 2 (1977). — *Pteridophyta*, 414 pages, 65 figures, by PROCTOR (with supplements in 1980).

Vol. 3 (1979). — *Monocotyledoneae* (less *Orchidaceae*), 586 pages, 122 figures, by HOWARD et al.

Vol. 4 (1988). — *Dicotyledoneae* (Part 1), 673 pages, 243 figures, by HOWARD et al.

Vol. 5 (1989). — *Dicotyledoneae* (Part 2), 604 pages, 199 figures, by HOWARD et al.

Vol. 6 (1989). — *Dicotyledoneae* (Part 3), 658 pages, 281 figures, by HOWARD et al.

98 families representing 1219 species are described by HOWARD, editor and principal monographer.

67 families representing 933 species are described by 17 authors including Elizabeth TAYLOR who contributed for the genus *Sterculia*.

These totals exclude families with only introduced species : *Tamaricaceae* (1 sp.), *Cochlospermaceae* (1 sp.), *Proteaceae* (2 sp.), *Lecythidaceae* (6 sp.) and *Strelitziaceae*.

TREATMENT OF THE FAMILIES

The sequence in volumes 3 to 6 follows ENGLER's system. Each family is shortly described, approximate numbers of genera and species are given at the world level (but regrettably not for the Lesser Antilles). Then follows a key for the genera, with a short description of each genus and a key to the species.

Each species is described according to a concise pattern, usually half a page to less than one page, giving : the accepted scientific name and its basionym, where and when it was published, the synonyms (usually a limited number), with references on publication and typification. Then a short botanical description (up to 20 lines, often much less). Finally in

short separate paragraphs the *General Distribution* (outside the Lesser Antilles) and the *Distribution in Lesser Antilles* (a list of islands in a north to south arrangement from Anguilla to Grenada and Barbados), with an exclamation mark when a specimen has been seen, without when it is quoted only from the literature.

Often vernacular names in English or French are mentioned, almost always followed by a copious, carefully written note offering critical views on taxonomy, or history of introduction and bibliography.

HOWARD endeavoured to illustrate at least one species for each genus with a line drawing, exceptionally full page, generally grouped in plates of fours, showing twig with leaf, flower and fruit, or flower, or fruit only, rarely with a dissection. These drawings are small and entirely original (FOURNET, 1978 on the contrary had heavily borrowed from LITTLE et al., 1964, 1974).

INTERNATIONAL COOPERATION

Botanists of many countries collaborated directly or indirectly in the past to the Flora of the Lesser Antilles, either through collecting, writing articles or local floras, revising genera or families. Main collectors were British, French, Swedish, Danish, German, Dutch, Swiss, American (Cuban, Dominican, Spanish or Canadian for the Greater Antilles).

However, with few exceptions (Japanese, Dutch,...), the monographers of the Flora of the Lesser Antilles are mostly from the U.S.A. and some from Great Britain.

ADDITIONS, OBSERVATIONS AND CRITICAL REMARKS ON THE "FLORA OF THE LESSER ANTILLES"

Floras are never perfect although modern ones are steadily approaching this ideal goal by complementing pure morphological descriptions with critical discussions on synonymy, geographical distribution, ecological data, chromosome numbers; rarely floral biology, experimental hybridization and chemotaxonomy and even less on molecular biology and advanced phylogeny.

At the time of the publication much information was available which could not be incorporated.

Having been involved in dendrological research for the decade 1979-1989 in the Lesser Antilles, I have concentrated my observations on volumes 4-5-6, i.e. on Dicots, and especially on trees.

SPECIES NOT MENTIONED IN THE FLORA

Among the materials recently collected and deposited in the herbarium of the Muséum National d'Histoire Naturelle in Paris several specimens represent species not (or dubiously) quoted in the Flora of the Lesser Antilles and that should be pointed out.

Wolffia brasiliensis Weddell. — The genus *Wolffia* is not mentioned in the Flora of the Lesser Antilles. According to LANDOLT (1986), *W. brasiliensis* is distributed all over the American continent (except cold regions). Presently this species has been found only in ponds of Martinique : *Jérémie* 1383, 1497, 1516, P; *Raynal-Roques & Jérémie* 21157, 21158 p.p. 21171, 21172 p.p. It had already been mentioned in Martinique by JÉRÉMIE & RAYNAL-ROQUES (1982).

Wolffiella welwitschii (Hegelm.) Monod. — This species has not been described in the Flora in the Lesser Antilles. It was collected in ponds of Grande-Terre in Guadeloupe (*Proctor* 19945, ZT; *Raynal-Roques & Jérémie* 21315 p.p., P, ZT) and of Marie-Galante (*Raynal-Roques & Jérémie* 21137, P, ZT). Specimens were determined and quoted by LANDOLT (1986).

Lemna minuscula Herter. — Not quoted in the Flora in the Lesser Antilles, this species has been presently collected in the Lesser Antilles only in Grande-Terre (Guadeloupe) : *Raynal-Roques & Jérémie* 21318, P, ZT. Specimens were determined and quoted by LANDOLT (1986).

Eleocharis minima Kunth. — This species is not mentioned in the Flora of the Lesser Antilles. Two specimens of Guadeloupe (*Duchassaing s.n.* and *Jérémie* 1424, P) prove its occurrence in the Lesser Antilles. Another specimen collected in Dominica without mature spikelets (*Jérémie* 1275, P) was mentioned by ADJANOHOON et al. (1985) and doubtfully ascribed to this species.

Hydrilla verticillata (L. f.) Royle. — This species is not quoted in the Flora of the Lesser Antilles; it has been mentioned for the first time in Dominica by ADJANOHOON et al. (1986) (*Jérémie* 1181, P), then by WHITEFORD (1989); it has been also collected in Marie-Galante (*Jérémie* 1928, P).

Sagittaria lancifolia L. — This species has been mentioned for the Lesser Antilles in several islands (FOURNET, 1978; HOWARD, 1979) : Guadeloupe, St. Martin, St. Kitts, Montserrat, Barbados, but no specimen has been quoted to substantiate this information, so that it has been classified by HOWARD among dubious species. In the herbarium of the Paris Museum, a specimen collected in Martinique (*Plée s.n.*) corresponds to *S. lancifolia*. This species probably no longer exists in the Lesser Antilles, or is very rare, for it has not been collected recently.

It is necessary to mention that the two Gymnosperms of the Lesser Antilles have been omitted : *Podocarpus coriaceus* L. C. Rich. and *Juniperus barbadensis* L. The reason for the omission of the former is possibly to be found in the distribution of the Flora in 6 volumes : Orchids, Ferns, Monocots and the last 3 volumes of the Dicots. *Podocarpus coriaceus* is scattered in the montane forests of the inner (non calcareous) portion of the Archipelago : St. Kitts, Nevis, Montserrat, Basse-Terre (Guadeloupe), Dominica, Martinique, St. Lucia and outside also Trinidad, Tobago and Puerto Rico, but not in Jamaica, Cuba, Hispaniola.

The story of *Juniperus barbadensis* L., the West Indian red cedar, is very particular. Probably due to an error in labelling it was named by LINNAEUS *barbadensis* but probably never occurred in Barbados. Long time overexploited in St. Lucia, the local newspapers said it was extinct by 1930. HOWARD himself shared this view. In 1985, climbing the Petit Piton close to the small town Soufrière (St. Lucia), Verne SLANE, a Peace Corps assistant in plant collecting came across the species near the summit (a little less than 900 m); it was promptly identified by HOWARD and confirmed by a specialist of the genus. News came that a fire was

kindled at the top of Petit Piton (probably not mischievously) by tourists. Some rare species are really fragile and endangered.

In the past authors considered the species as a synonym of *J. lucayana* Britton of the Bahamas and Cuba, and also synonym of *Juniperus bermudiana* L. Now they are considered close but distinct. *Juniperus bermudiana* L. (= *Sabina bermudiana* (L.) Antoine) the Bermuda Cedar or Bermuda Juniper, now considered endemic is gregarious and surviving in small clumps, the biggest measured (in 1912) reached 21 m and 150 cm dbh.

In the little forested thalwegs of the eastern lowlands of Basse-Terre (Guadeloupe) a palm with a well-developed stipe has been (mis?-) identified by FOURNET (1978 : 397) as *Elaeis guineensis* Jacq.; READ (vol. 3) does not mention it but considers *Raphia farinifera* (Gaertn.) Hylander as introduced and common in Martinique, less common in Guadeloupe, in coastal lowlands and along river courses "with short obscure caudex of leaves direct from the ground". In reality the species may be *Elaeis oleifera* (Kunth) Cortes, the American oil palm mentioned by UHL & DRANSFIELD (1987 : 516); the species is native to Central and Northern South America.

ADDITIONS TO SPECIES DISTRIBUTION

Several recently collected specimens contribute to improve the geographic distribution of some species in the Lesser Antilles.

Wolffiella lingulata (Hegelm.) Hegelm. — This species is included in the Flora in the Lesser Antilles : HOWARD quotes Guadeloupe but points out that he did not see any specimen. Specimens determined and quoted by LANDOLT (1986) were collected in Grande-Terre, Guadeloupe (*Raynal-Roques* 20235, P; *Raynal-Roques & Jérémie* 21087, 21088, 21315 p.p., 21316, 21318, P, ZT) and in Marie-Galante (*Raynal-Roques & Jérémie* 22137 p.p., 21138, 21139 p.p., 21140 p.p., P, ZT). Other specimens collected in Antigua (*Jérémie* 933, 937, P; *Raynal-Roques & Jérémie* 21919, 21937, P) refer also to this species.

Lemna aequinoctialis Welwitsch. — A species distributed all over the tropics, named *L. perpusilla* Torrey by HOWARD (1979). According to LANDOLT (1986), the latter is endemic in North eastern America so that when it is applied to specimens from other regions, the correct name is *L. aequinoctialis*, and Marie-Galante should be added to the list of islands given by HOWARD (*Raynal-Roques* 19611, P; *Raynal-Roques & Jérémie* 21120, 21122, 21139 p.p., 21140 p.p., P, ZT).

Potamogeton nodosus Poir. — This very rare Lesser Antilles species is mentioned for Dominica and Martinique in the Flora of the Lesser Antilles. It occurs also in Guadeloupe, as mentioned in FOURNET (1978) where *l'Herminier s.n.*, May 1843, and *Raynal-Roques & Jérémie* 21309 (both P) were collected.

Najas guadalupensis (Spreng.) Magnus. — Occurs in Antigua and Guadeloupe after HOWARD. The following two islands can be added : St. Lucia (*Jérémie* 810, P) and Marie-

Galante (*Raynal-Roques & Jérémie* 21125, 21126, 21145; *Jérémie* 622, 758; *Rodriguez* 4384; all in P).

Heteranthera reniformis Ruiz & Pavon. — An American species, very rare in the Lesser Antilles. HOWARD mentions it without certainty for Antigua and Guadeloupe. It is not mentioned in FOURNET's *Flore de Guadeloupe et de Martinique* (1978). It was found in a pond of Grande-Terre, Guadeloupe (*Raynal-Roques & Jérémie* 21101, P) and in a pond of Marie-Galante (*Jérémie* 620 and *Raynal-Roques & Jérémie* 21130, P).

Wulfschlaegelia aphylla (Sw.) Rchb. f. — This South American orchid has been mentioned by GARAY & SWEET in HOWARD (1974) in Dominica. It was also collected in Guadeloupe in 1974 (*Jérémie* 163, P).

Limnobium spongia (Bosc) Steudel subsp. *laevigata* (Humb. & Bonpl. ex Willd.) Lowden. — Species retained by HOWARD under the name of *Limnobium laevigatum* (Humb. & Bonpl.) Morton. To the 5 mentioned islands (Antigua, Montserrat, Guadeloupe, Martinique and St. Lucia) should be added Marie-Galante (*Jérémie* 507 and *Raynal-Roques & Jérémie* 21128, P).

Pilocarpus racemosus Vahl. — This species is mentioned for Montserrat, Guadeloupe and Martinique in the *Flora of the Lesser Antilles* (HOWARD, 1988). Although it has been quoted for Dominica by ADJANOHOUN et al. (1985) based on specimens of *Aké Assi & Portecop* 16417 and *Jérémie* 1214 (P), it has not been retained by NICOLSON (1991). The genus *Pilocarpus* has to be added to the flora of Dominica.

Mecardonia procumbens (Mill.) Small. — FOURNET (1978) quotes this species for Martinique under the name of *Pagesia dianthera* (Sw.) Pennell and considers it is very rare. HOWARD (1989, vol. 6) mentions it in 6 other islands to which Guadeloupe should be added (*Raynal-Roques & Jérémie* 21302, P).

Pfaffia iresinoides (Kunth) Sprengel. — This species is quoted in the *Flora of the Lesser Antilles* for Guadeloupe (without!) and St. Lucia. ADJANOHOUN et al. (1985) mention it for Dominica (*Aké Assi & Portecop* 16368, P) and it is often cultivated as a medicinal plant in the French Antilles as FOURNET (1978) points out.

Ilex nitida (M. Vahl) Maxim. — This species is quoted in the *Flora of the Lesser Antilles* for Antigua, Montserrat, Guadeloupe!, Marie-Galante and Martinique! ADJANOHOUN et al. (1985) mention it for Dominica (*Aké Assi & Portecop* 16439; *Jérémie* 1223, P) but it has not been retained by NICOLSON (1991) and therefore has to be added to the *Flora of Dominica*.

Epidendrum difforme Jacq. — Add Montserrat (*Jérémie* 1831, P) to the 8 islands quoted by GARAY & SWEET in HOWARD (1974).

Spiranthes lanceolata (Aubl.) Leon. — Add Marie-Galante (*Raynal-Roques & Jérémie* 21141, P) to the ten islands quoted by GARAY & SWEET in HOWARD (1974).

Ruppia maritima L. — Add St. Martin (*Jérémie* 1402, P) to the islands quoted by HOWARD (1979).

Pistia stratiotes L. — Add St. Lucia (*Jérémie* 825, P) to the six islands quoted by HOWARD (1979).

Eichhornia crassipes (Mart.) Solms in DC. — Add St. Martin (*Jérémie* 1406, P) to the seven islands quoted by HOWARD (1979).

Struchium sparganophorum (L.) Kuntze. — Add St. Martin (*Jérémie* 1405, P) to the 5 islands quoted by HOWARD (1989, vol. 6).

The presence of some species is highly probable in some islands even if they have not been collected. The following species have been spotted by ROLLET.

Meliosma herbertii Rolfe escaped for a long time the keen eye of J. P. FIARD, the eminent connaisseur of the trees of Martinique although the species had been mentioned a century ago by DUSS.

Brunellia comocladifolia Humb. & Bonpl. was spotted in Guadeloupe by STEHLÉ, later on it was impossible to locate it again, and finally after many years it was relocated : the species may be a recent introduction (one tree only 10 cm dbh in 1980 on the Soufrière at 960 m altitude; *Rollet* 241, GUAD). It is indigenous and frequent above 600 m in Hispaniola, in Jamaica, Cuba, Puerto Rico and also in northern South America. HOWARD mentions the species in vol. 4 : 315 without comment. LITTLE & WADSWORTH (1964 : 136) note the species for Guadeloupe, also without comment. FOURNET (1978 : 677) notes that the species is absent in Martinique and very rare in Guadeloupe, possibly in a process of extinction. It could be as well an expanding species in the Lesser Antilles (between the Greater Antilles and the northern part of South America).

Guaiacum officinale L. Add rare sites in Marie-Galante (difficult to relocate when one is unfamiliar with them); one highly probable site in Grande-Terre (Guadeloupe) could not be relocated.

Avicennia germinans (L.) L. Add Dominica.

Avicennia schaueriana Stapf & Leechman. Add Barbados and Guadeloupe : discontinuous sites with only few trees in Guadeloupe; difficult to say whether it is in progression or in regression.

Forestiera eggersiana Kr. & Urb. is mentioned only in St. Barthelemy. Add : St. Martin, La Désirade, Anguilla, although the latter was noted by HOWARD himself in 1987 (*J. Arnold Arboretum* 68 : 126).

Quararibea turbinata (Sw.) Poiret. Presence in Guadeloupe (Basse-Terre) is confirmed (*Huc* 1256, *Rollet* 1345, GUAD); when HOWARD (vol. 5 : 272) says Guadeloupe(?) he merely reproduces the information from FOURNET (1978 : 1520) who says : presence in Guadeloupe dubious and who himself reproduced it from DUSS (1897). Presence in Barbados also confirmed by ROLLET (HOWARD quoted the literature without any evidence from herbaria).

Diospyros revoluta Poiret, vol. 6 : 72. Add St. Kitts : though not collected it has been spotted beyond any doubt by FIARD & ROLLET.

Hieronima laxiflora (Tul.) Muell.-Arg. HOWARD (vol. 5 : 59) gives only Dominica, St. Lucia and St. Vincent. Add Guadeloupe and Grenada and note that the species is over exploited in St. Lucia and becoming rare. Its presence in Guadeloupe and Martinique had been mentioned by STEHLÉ. ROLLET located 3 sites in Guadeloupe whereas FIARD could not relocate the species in Martinique.

One could add many islands for the distribution of the *Myrtaceae*, though well investigated by McVAUGH, and for a number of other families.

The general impression is that the whole work could have been improved concerning species distribution with more field work and collecting, at least for families with trees. Retrieving Volumes 1 and 3 for distributions in Dominica (see additional notes below), I got the feeling that it might apply as well to *Poaceae* and Orchids.

However, intensive field work shows that even careful observations can miss species for a long time. One must come across an individual when the species is rare or very scattered in the forest. It may happen that one is incapable to spot it again, even knowing that it exists.

INTRODUCED AND NATURALIZED SPECIES

It is easy to say that a species is fully naturalized when time of introduction is known. Some species never escape plantations, others are persisting after plantation or are being naturalized. Moreover food crops and fruit-trees were already there in 1492 and could have been propagated by the Caribs (e.g. the Annonas, *Spondias mombin*, *Melicoccus*, several *Sapotaceae*).

With these difficulties in mind, one would have nevertheless expected a more homogeneous and rational treatment of cultivated plants throughout the flora and some accepted rule among the various collaborators. For instance naturalized species could have been fully described in the same way as indigenous species, while lists of species being naturalized and cultivated species would have been set aside always in the same place in the pattern of genera descriptions.

Why should some cultivated species be fully described and others not? Possibly on the grounds of usefulness? But where one should stop?

HOWARD describes at length *Blighia acida* König, a fruit-tree from Africa which is not naturalized, also *Mimusops elengi* L. a Sapotaceous species from the Far East, saying (vol. 6 : 63) "in some areas producing numerous seedlings with the potential of escaping". For *Hevea brasiliensis* Muell.-Arg. (vol. 5 : 54) : "planted in rows in mountainous areas and naturalized". The species originates from the moist lowlands and riverbanks of Amazonia. I have never seen the species escaping from *Hevea* plantations of the Far East with over a billion of trees. That the species does well in the highlands of the Lesser Antilles and naturalizes is difficult to believe.

Why describing, along with *Spondias mombin* two other *Spondias* that never naturalize (*S. cytherea* and *S. purpurea*, vol. 5 : 101, 103)?

Six species of *Lecythidaceae* (vol. 5 : 443-446) are fully described whereas they are grown only in Botanic Gardens and are completely alien to the region. The same applies to *Cochlospermum*, *Carica*, *Phyllanthus acuminatus*, *Strelitziaceae*...

The status of *Mangifera indica* as a naturalized species is controversial.

DUBIOUS INDIGENOUS SPECIES

Metopium toxiferum (L.) Krug & Urb. is mentioned by BORNSTEIN (vol. 5 : 99-100) in Anguilla and Dominica without exclamation mark, i.e. only quoted from literature and without comment. It is improbable that it is indigenous in Dominica and even that it has ever been cultivated at the Botanic Gardens, Roseau (Dominica); it is not mentioned in the anonymous official guide of the Gardens (1948). The probability would be higher for Anguilla but the last visit and collections by HOWARD & KELLOGG (1987) does not mention the species. STOFFERS (pers. comm.) definitely thinks that the species does not occur in St. Martin, Saba and St. Eustatius.

Carapa guianensis Aubl. may have been introduced in some islands. It has not been found in Martinique. There is one site in Basse-Terre (Guadeloupe) where seedlings are abundant below the mother tree in a moist site and possibly initiating a process of naturalization; this fact is insufficient to state that the species is indigenous.

Richeria grandis Vahl (vol. 5 : 83) : HOWARD says Marie-Galante!; this means that the specimen has been seen in a herbarium. Is this an error of labelling? The island is far too dry and too low for the existence of such a species unless it has been planted for aphrodisiac uses.

A considerable confusion originated from an anonymous publication (1893) on specimens collected in St. Vincent without a clear indication of the sites. Most were probably collected in the Botanic Gardens and further on quoted carelessly as being indigenous in St. Vincent.

DUBIOUS ENDEMIC SPECIES

Clidemia umbrosa (Sw.) Cogn. is considered an endemic of the Lesser Antilles by HOWARD, but LITTLE et al. (1974) think that the species is present in Puerto Rico.

Maytenus grenadensis Urb. (vol. 5 : 121-122) is considered an endemic of Grenada. The species was collected but once, in 1896. The holotype has been probably destroyed; it is close to *M. tetragona* Griseb., a non-endemic which HOWARD considers a distinct species. But does it still exist?

Calypttranthes boldinghii Urb., a treelet collected once in St. Martin has to be accepted with caution as an endemic. However, another species of *Myrtaceae* known from a very limited area (Montagne du Vauquelin, Martinique), *Eugenia gryposperma* Krug & Urb. ex Urb. is a genuine endemic.

READ (vol. 3 : 332-339) questions the reality of an endemic *Aiphanes* for each of the four islands : Dominica, Martinique, St. Lucia and St. Vincent and calls for a revision of the genus; he retains provisionally only 2 endemics.

Consequently the rate of endemism of the Lesser Antilles is liable to revision. According to a careful checking (see below) it seems that this rate for flowering plants in the Lesser Antilles is 13 or even 14 rather than 12% as indicated in HOWARD (1979 : 244).

In general terms, the published rates of endemism are to be accepted with care. LIOGIER gives 7,5% for Puerto Rico, whereas HOWARD (1979) says 4%. The latter suggests 13% for the Bahamas but CORRELL & CORRELL say 9%. These discrepancies are too large to leave phytogeographers unpreoccupied and must draw the botanists' attention to the incompressible incertitude in taxonomy.

SPECIES COLLECTED ONCE, OR NOT COLLECTED RECENTLY

Tetrorchidium rubrivenium Poeppig (vol. 5 : 80) is a species from northern South America, collected once in 1890 by H. H. SMITH et al. in St. Vincent; HOWARD says possibly in the Botanic Garden; it was never recollected. Same situation for *Ludwigia decurrens* Walter.

Oreopanax ramosissimum A. C. Smith is only known from the type collected by PERROTTET in Martinique, never relocated or collected since.

The presence of *Trichilia martiana* C. DC. (only St. Vincent) and of *T. hirta* L. (only in Grenada) is puzzling. *Calyptanthus boldinghii* Urb. and *Sideroxylon cubensis* (Griseb.) Penn. have been mentioned before.

However, every now and then, species never recollected for a long time are sometimes recollected, e.g. *Miconia acinodendron* (L.) D. Don, a treelet collected in 1820 by PLÉE in Martinique has been relocated in 1980 at Grand Rivière (Crête de Balata) by SASTRE (vol. 5 : 554). *Hyeronima laxiflora* and *Brunellia comocladifolia* fall in this category. One of the most noteworthy case is *Juniperus barbadensis* L. (see above). This occurs not infrequently for rare species and should draw the attention to the absolute necessity of being very careful before proclaiming a species extinct.

REMARKS ON DIMENSIONS INDICATED FOR THE TREE SPECIES

Dimensions indicated for trees are generally very underestimated, e.g. :

Myrcianthes fragrans (vol. 5 : 513) : "shrub or small tree to ca. 15 m". Individuals 20 m high and 70 cm dbh and over have been seen in St. Lucia.

Symplocos guadelupensis (vol. 6 : 74) : "small tree to 4 m tall". Can reach 15 m high and 20 cm dbh.

Tabebuia heterophylla (vol. 6 : 332) : "to 20 m tall". An enormous tree 30 m high and 205 cm dbh has been spotted in Martinique.

Homalium tomentosum (vol. 5 : 357) : "shrub or more often a tree to 15 m tall (rarely more) trunk to 35 cm in diameter". Trees over 1 m dbh are not infrequent : 105, 120, 170 cm dbh have been observed in Martinique.

On the other hand some dimensions seem somewhat exaggerated, e.g. :

Sloanea caribaea (vol. 5 : 180-181) : "tree to 60 m tall". The biggest known to date was spotted by FIARD in Rivière de la Pirogue, Morne Jacob, Martinique, ca. 200 cm dbh, 40 m.

Buchenavia tetraphylla (vol. 4 : 454) : "to 30 m tall and 3 m in diameter". Over 100 cm dbh in Guadeloupe; 120 cm between Terreville and Concorde, Martinique.

Conocarpus erectus (vol. 5 : 457) : "trunk to ca. 1 m diameter". I never observed in the Lesser Antilles trees much above 50 cm but I think this species can reach 60 cm and over. It would be interesting to check the source of information given by HOWARD.

Bucida buceras (vol. 5 : 456) : "20-25 m tall and to 1.5 m in diameter". This is likely; I measured a tree 120 cm dbh in Antigua; LITTLE & WADSWORTH (1964), 2nd edit. : 532, record an exceptional individual 180 cm dbh in Jost van Dyke Island in British Virgin Islands.

Concerning *Sloanea dussii* (vol. 5 : 182) : “ tree of unknown dimensions ”. I observed a tree on Plateau Concorde, Martinique, 80 cm dbh, 25 m + .

Foresters measure the trees, Botanists do not or very often in a biased way. This is an appeal that botanists should carry a light cloth 3 m long diameter tape in the field.

DISTRIBUTION OF LESSER ANTILLES SPECIES ACCORDING TO THEIR ORIGIN

I found nowhere statistics on the number of indigenous species in the Lesser Antilles. An earlier question to HOWARD on this point being left unanswered, I went painstakingly through five of the 6 volumes of the Flora (Ferns of vol. 2 are not considered here) adopting a classification according to origins similar to what is found in FOURNET (1978 : 11-16) i.e. indigenous, naturalized, naturalizing, cultivated, dubious origin or presence, with only slight modifications (pantropical species and endemics are set aside and should be added to indigenous species) for a comparison with FOURNET's data. Dubious origins were tallied with question-marks.

In Volume 2, PROCTOR gave for the ferns 323 indigenous species with an endemism rate of 14 %.

For the flowering plants, we obtained the following table :

PANTROPICAL	INDIGENOUS	ENDEMIC	NATURALIZED	BEING NATURALIZED	TOTAL
183	1454 (+ 8?) + 1 (<i>Podocarpus</i>)	280 (+ 7?) + 1 (<i>Juniperus</i>)	183 (+ 9?)	25?	2102 (+ 49?)

The last category (with 25?) is poorly defined since all sorts of stages exist between fully naturalized species (e.g. *Haematoxylon*), persisting after cultivation (*Pouteria sapota*, vol. 6 : 65), or “ with potential of escaping ” (*Mimusops elengi*, vol. 6 : 63).

The status of some species naturalized or not are liable to varied opinions. For *Anacardium occidentale* HOWARD says (vol. 5 : 96) : “ Cultivated throughout the tropics; native to tropical America ”; his enumeration of islands gives the impression that he considers the species indigenous all over the Lesser Antilles. FIARD (pers. comm.) follows DUSS who considered it indigenous in Martinique; NICOLSON says indigenous also in Dominica but I find it hard to believe it indigenous in Guadeloupe.

Mangifera indica is considered by HOWARD naturalized throughout the tropics (vol. 5 : 98); this seems to me somewhat an overstatement; persisting after cultivation or rarely escaping seems closer to reality.

From the Table, Pantropical + Indigenous + Naturalized species add up to 1821 + 42? and Endemics 281 + 7?. According to how the endemism ratios are calculated and because of the uncertain status(?) of some species, these ratios can be something between $281/2151 = 13.0\%$ and $288/2108 = 13.7\%$ if one drops the uncertain naturalized and endemic species or not, which is in both cases slightly higher than the 12% earlier proposed (HOWARD, 1979 : 244) and getting closer to the figure of PROCTOR for the ferns (14%).

The uncertainty about endemics is a possible underestimation of about 2%. If naturalized species are discarded the ratio becomes $(281 + 7?)/(1638 + 33?) = 17.1\%$ with 2% uncertainty.

It is also interesting to compare the figures of the Table for the whole Archipelago (6280.5 km²), with FOURNET's data (1978 : 16) for Guadeloupe (+ dependencies) and Martinique only (2805.5 km²).

Grand total for the Archipelago is 2102 (+ 49?).

Grand total for Guadeloupe-Martinique is 2027 with 97 species of dubious status.

It is very unlikely that doubling the area would add only about 4 or 5 %, i.e. an extra 75 species (or 75 + 49?). Concerning tree families like *Lauraceae* and *Sapotaceae* FOURNET describes respectively 26 and 16 species whereas HOWARD retains only 25 and 11 species excluding *Persea* and *Cinnamomum* for *Lauraceae*, *Calocarpum*, *Chrysophyllum cainito*, *C. oliviforme*, *Mimusops elengi* for *Sapotaceae*.

Must one conclude that FOURNET distinguished too many species or that HOWARD lumped too much?

I retain the updated work of HOWARD for comparison. The seemingly overestimated floristic richness given by FOURNET indicates anyway that knowing the Flora of Guadeloupe and Martinique means that 85 %, possibly 90 % of the Flora of the Archipelago is known.

The mountainous islands of the Archipelago represent by far the bulk of the floristic richness of the region.

MISPRINTS

Misprints are very few. Just some examples will be mentioned. In volume 3 : 477, fig. 105 refers to caption of fig. 106 and vice versa; in volume 4 : 368, concerning *Mimosa malacocentra*, instead of Rivière Sallé, *Rollet 1733*, read Rivière Salée, *Rollet 1722*; in volume 5 : 85 instead of Bois Bande, read Bois Bandé; in volume 5 : 117 concerning *Celastrus racemosus* scandent shrub to 50 m (?) tall, the error is probably in the label itself, read 50 cm; in vol. 6 : p. vii Eruption of Mt. Pelée in 1900, read 1902.

FINAL REMARKS

— HOWARD announced a key of the families in the introduction of vol. 4, which appears nowhere.

— There is a lack of ecological information throughout the work (altitudes, vegetation types, phenology).

— HOWARD regretted that floral biology could not be taken into account.

— With a new flora available, one would imagine that the modelization of floristic richness in the Archipelago is an easy operation. It is not the case for various reasons : Knowledge about presence of all the species in the various islands is far from complete, their distribution among vegetation types is still too rough and a sensible evaluation of the area of these types is still to be done.

— An introduction to the vegetation of the Lesser Antilles (reproduced essentially from HOWARD, 1979) is found in vol. 2, *Orchidaceae*. A short historical background of the Botany in the region is outlined in the four introductory pages of vol. 4 and part of vol. 6 : p. viii,

indicating the main available floras for the Caribbean. One would have preferred a grouping of these materials at the beginning of the Flora.

— I hope the price of the 6 volumes will not be a limiting factor to the circulation of the Flora of the Lesser Antilles.

REMARKS ON "THE FLORA OF DOMINICA"

The first part of the Flora of Dominica (Pteridophytes and Monocotyledons) published in 1954 by HODGE will not be reviewed here since it has been updated by the 3 first volumes of HOWARD's Flora of the Lesser Antilles (1974, 1977, 1979).

The much awaited second part, *Dicotyledoneae* has been published in 1991 by Dan H. NICOLSON as number 77 of the *Smithsonian Contributions to Botany*, 274 pages. It covers 123 families, 482 genera and 844 species. For the sake of comparison I distributed the dicots species in categories as above : pantropical, indigenous, etc., using HOWARD's Flora for the Monocots. Cultivated species have been excluded.

	PANTROPICAL	INDIGENOUS	ENDEMIC	NATURALIZED	BEING NATURALIZED	TOTAL
Dicots (NICOLSON)	76 + (1?)	624 + 12(?)	6 + 1 var. (+ 1?)	54	44 (+ 6?)	805 + (20?)
Monocots (HOWARD)	1	268 + 2(?)	2	5	1 (+ 1?)	277 + (3?)
TOTAL	77 (+ 1?)	892 (+ 14?)	8 + 1 var. (+ 1?)	59	45 (+ 7?)	1082 + (23?)

The estimated total of flowering plants for Dominica is 1082 (+ 23?).

STRUCTURE OF THE FLORA

After a short introduction on the environment of Dominica a key for the families p. 7-14 is provided followed by the treatment of each family in alphabetical order. Each species is shortly described with ecological data (vegetation types, altitude...) its status (indigenous, naturalized) and critical notes on taxonomy.

In the reprise of his volume 6, HOWARD (1989 : viii) refers to Dan H. NICOLSON as a most valued correspondent adding "I hope that I have followed all his astute advice on nomenclatural problems".

Actually there are but few differences in the updating of scientific names between the two authors e.g. *Ficus perforata* L. in NICOLSON, *F. americana* Aubl. in HOWARD; *Ficus obtusifolia* Kunth in NICOLSON, *F. nymphaeifolia* Miller in HOWARD. *Rondeletia parviflora* and *R. stereocarpa* are distinct species for NICOLSON whereas HOWARD pool them under *R. stereocarpa*. *Melicoccus bijugatus* is said to be indigenous all over the Lesser Antilles by HOWARD (vol. 5 : 146-147) whereas FOURNET (1978) says naturalized in all the Islands; it is considered an introduction by NICOLSON.

As in HOWARD's Flora, heights or diameters are generally underestimated (even more than in HOWARD) possibly for lack of field check or merely inadequate label records, e.g. *Guatteria caribaea* : 6 m; *Acacia muricata* : small tree; *Erythrina corallodendron* : 3 m; *Byrsonima lucida* : shrub 1-3 m; *Gomidesia* : shrub or small tree; *Trema lamarckiana* : to 2.5 m; *T. micranthum* : to 3 m, etc., etc... On the other hand some are grossly overestimated, e.g. *Sterculia caribaea* : dbh to 3 m; *Carapa guianensis* : 50 m; *Trichilia septentrionalis* : 40 m; *Buchenavia tetraphylla* : 3 m dbh (LITTLE & WADSWORTH, 1964 say 120 cm; individuals 100 cm in Guadeloupe, 120 cm in Martinique have been recorded).

ENDEMISM IN DOMINICA

Eugenia hodgei (p. 5) is mistakenly given as an endemic in Dominica; NICOLSON (p. 164) says the species is present in Dominica and Martinique. Actually it has been spotted in Guadeloupe also.

There are 7 species considered endemic to Dominica by NICOLSON (*Eugenia hodgei* should be discarded) and a variety : *Charianthus purpureus* var. *rugosus* which is not recognized distinct from *C. purpureus* by HOWARD; plus a dubious species. The endemic percentage is therefore $8 (+ 1 ?) / 1082$ or $8 (+ 1 ?) / 978$ if naturalized species are excluded i.e., a little less than 1 % for Dominica. Three taxa are trees : *Miconia ernestii* Wurdack, *Sabinea carinalis* Griseb. (the national tree of Dominica) and *Charianthus purpureus* var. *rugosus*.

ADDITIONS TO THE FLORA AND REMARKS

— Species missing or not mentioned by NICOLSON : *Cybianthus antillanus* (Mez) Agostini (HOWARD, vol. 6 : 44, quotes it from literature for Dominica), *Licaria salicifolia*, *Sideroxylon obovatum*. *Avicennia germinans* and *Conocarpus erectus* were spotted by ARLINGTON JAMES (1989) in Northern Dominica.

— Additions of NICOLSON (missed by HOWARD) : *Charianthus purpureus* var. *rugosus* (missed as an endemic variety; the species is endemic to the Lesser Antilles); *Prunus pleuradenia* (quoted by HOWARD from literature, confirmed by NICOLSON); *Dodonaea viscosa*, *Sideroxylon salicifolium*.

— Additional species (not mentioned by HOWARD or NICOLSON) : *Hydrilla verticillata*, *Eleocharis minima*, *Pilocarpus racemosus*, *Pfaffia iresinoides* and *Ilex nitida* are to be added to the flora of Dominica (see above). *Myrcianthes fragrans*, *Ouratea guildingii*, *Zanthoxylum flavum* (records only from Guadeloupe and Marie-Galante northwards), *Hernandia sonora* (this pantropical species has to be looked for in the lower river courses), *Pisonia suborbiculata* (HOWARD, vol. 4 : 181, quotes it from the literature; NICOLSON says perhaps in Dominica), *Suriana maritima* (mentioned by HODGE only), *Avicennia schaueriana*, are likely to be collected.

SOME MISPRINTS AND ERRORS

Area of Dominica is not 1088 km² but 751 or 778 km² according to various sources.

Eugenia hodgei (p. 5) see above; *Rollinia muscosa* (p. 23) : read *mucosa*; *Laguncularia* (p. 68) : “prop-rooted tree” is wrong; pneumatophores only, sometimes spurs.

Errors in dimension reached by species : see above.

UNDERESTIMATION OF THE NUMBER OF FLOWERING PLANTS IN DOMINICA

I believe that the floristic richness of Dominica is almost certainly underestimated in NICOLSON's Flora.

The ratio between the total number of species and the number of tree species (capable of reaching 10 cm dbh) fluctuates within predictable limits and tends towards a characteristic value for any flora or region.

In the present situation of knowledge, this ratio for the Lesser Antilles is 2102 (+ 49?)/473 (+ 5?), i.e. about 4.4.

307 tree species (10 cm dbh and over) were identified in Dominica, independently from NICOLSON's work. Since 1082 (+ 24?) species of flowering plants are known from NICOLSON treatment of Dicots and updated HOWARD's treatment of Monocots, a ratio 1082 (+ 24?)/307 i.e. about 3.5 is obtained, which is too different from the above 4.4 ratio in the region.

Assuming that the number of tree species would increase with a better knowledge of the tree flora of Dominica, the ratio 3.5 would increase even more. The numerator 1082 of the fraction should be larger.

Therefore we can expect for Dominica about $307 \times 4.4 = 1360$ species, i.e. almost 300 additional indigenous flowering species to be collected in Dominica in the future.

CONCLUSION

One of the most valuable aspects of HOWARD's work lies certainly in an advanced updating of synonymy and a clarification about types based on a careful search in various herbaria.

The principal messages I got from the too few exchanges through letters or during some joint field trips are that botanists overdescribed the flora of the West Indies (HOWARD, 1979 : 248) and did not compare enough their specimens with the existing materials in the herbaria : some botanists have created unnecessarily new species and the flora should be described “without regard to political division, which in my opinion is the worst possible distinction where science is concerned” (HOWARD, 1979 : 248). He said (1974 : 16) that no more than 10% of the genera have been monographed in the region.

Easily accessible sites yielded recently additional records for Dominica : *Avicennia germinans* and *Conocarpus erectus*. Active collecting by Verna SLANE in the eighties brought (or rediscovered) new endemics for St. Lucia (*Daphnopsis macrocarpa*, *Calliandra slanae*, *Juniperus barbadensis*).

Intensive field work shows that rare species easily escape notwithstanding the keenest search.

No doubt that a careful search in little visited (montane) areas would add more species to the Flora of Dominica, the less disturbed island of the Archipelago, and in more general terms to the floras of St. Vincent and Grenada which are believed to be still undercollected.

Are there many species in the Lesser Antilles still to be discovered? It is accepted that the best temperate floras are known with a margin of error of at least 10%. More collecting and additional sites in the various islands are needed to provide the necessary adjustments on endemism. With over 2000 flowering plants the Lesser Antilles represent about a quarter of the total flora of the Greater and Lesser Antilles, estimated to be 8000 indigenous species (HOWARD, 1974 : 37) a rather underestimated evaluation (if LIOGIER's figures 1982, 1 : 12 are trusted).

It is almost certain that a close examination of recent collected specimens would add some additional species and sites for the Flora of the Lesser Antilles.

In spite of slight shortcomings, I believe that the first long needed synthesis on the Flora of the Lesser Antilles will be well received. We hope that Richard A. HOWARD will be able to complete his work on the region by producing a History of the Botany in the Caribbean to which he contributed very much as one of the best specialists.

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Végétation des milieux aquatiques stagnants des Petites Antilles et relation entre la minéralisation des eaux et la distribution des macrophytes

J. JÉRÉMIE & B. JEUNE

Résumé : Les divers types de milieux aquatiques stagnants des Petites Antilles sont décrits, et les espèces macrophytiques qui les peuplent sont énumérées. Des relevés de végétation associés à des mesures de conductivité des eaux ont permis d'établir des profils indicateurs pour une trentaine de taxons, et de mettre en évidence des espèces indicatrices de la minéralisation de ces milieux.

Summary : The various stagnant aquatic environments of the Lesser Antilles are described, and an enumeration is given of the macrophytic species found in them. Vegetation studies associated with measurements of conductivity of the water have established tolerance profiles for some thirty taxa, and pin-pointed indicator species for the degree of mineralisation of these environments.

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Le but de ce travail est d'analyser la végétation des milieux aquatiques stagnants des Petites Antilles, milieux très diversifiés et méconnus (essentiellement en raison des difficultés de prospection), et d'établir une relation entre la minéralisation des eaux et la distribution des macrophytes (Phanérogames, Ptéridophytes, Characées). Les travaux sur la végétation aquatique des eaux douces à saumâtres de cet archipel sont peu nombreux et généralement ponctuels (PINCHON, 1971; POINTIER et al., 1981; DE FOUCAULT, 1978, 1983; JÉRÉMIE & RAYNAL-ROQUES, 1978, 1982; FOURNET, 1981; GUERLESQUIN, 1983, 1985). Ces milieux n'ont encore fait l'objet d'aucune étude globale et la flore qu'ils hébergent mérite d'être mieux connue. L'étude que nous avons réalisée a pu se faire grâce aux missions effectuées de 1977 à 1991 par l'un de nous (J. J.) dans la plupart des îles de l'archipel. De nombreux milieux aquatiques stagnants (presque 500) ont été prospectés; les espèces macrophytiques ont été récoltées ou recensées et des analyses physico-chimiques des eaux ont été réalisées. Cette étude est donc fondée sur l'observation d'un nombre important de mares, marécages et étangs dans lesquels la quasi totalité des espèces aquatiques macrophytiques des Petites Antilles ont été trouvées. La relation mise en évidence entre certaines espèces et la minéralisation des eaux pourra par conséquent être appliquée à toutes les îles de l'archipel.